Ocean & Coastal Management 102 (2014) 47–54

Contents lists available at ScienceDirect

Ocean & Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

Review

Economic instruments and marine litter control☆

Frans Oosterhuis [a], Elissaios Papyrakis [a, b, c, *], Benjamin Boteler [d]

[a] Institute for Environmental Studies, VU University Amsterdam, De Boelelaan 1087, 1081 HV Amsterdam, The Netherlands
[b] School of International Development, University of East Anglia, Norwich NR4 7TJ, UK
[c] Institute of Social Studies (ISS), Erasmus University, Kortenaerkade 12, 2518 AX, The Hague, The Netherlands
[d] Ecologic Institute, Pfalzburger Strasse 43-44, D-10717 Berlin, Germany

ARTICLE INFO

Article history:
Available online 16 September 2014

ABSTRACT

This paper provides a comprehensive up-to-date review of the literature on the economic instruments that can reduce marine litter. We assess their cost of implementation, level of effectiveness as well as indirect environmental and socio-economic effects (externalities) that may arise as a result of their implementation. The evidence points to an overall beneficial impact of environmental taxes on items such as plastic bags in terms of reduced use, as well as a corresponding low cost of implementation. In the same vein, deposit-refund schemes can achieve high return rates for bottles although at a relatively high cost (especially when the scheme targets a wide range of packaging types). In the case of municipal waste collection, a 'pay-as-you-throw' charge can be applied to incentivise waste reduction. In coastal areas, waste collection and treatment can be further supported by the collection of tourist taxes, although there is a high risk that these funds might be used for other purposes. In the fishing industry, rewards for fishing vessels that return waste to shore has been shown to both reduce marine litter as well as complement fishermen's income. Since the vast majority of marine litter comes from land-based sources and consists of plastic, economic instruments that target relevant sources of land-based litter more broadly stand to make the greatest contribution to marine litter reduction. The choice of an appropriate intervention is case specific, largely depending on the tackled source of pollution, the country's institutional characteristics and infrastructure, consumer preferences and habitual behaviour, and the economy's overall sectoral composition.

1. Introduction

Much of our solid waste ends up in the sea as marine litter as a result of poor waste management, limited awareness of the public and inadequate interventions from industry and policy-makers. Since plastic waste material gradually degrades into microscopic pieces, the effects of marine litter are not only aesthetic but extend to the domain of biodiversity loss and human health (Thompson et al., 2009). In the Rio+20 Summit declaration "The Future We Want", participant countries committed to take action to significantly reduce marine litter by 2025 in order to prevent harm to the coastal and marine environment. The EU Marine Strategy Framework Directive commits member states to achieve (or maintain) 'Good Environmental Status' (GES) for the marine environment by 2020. One of the descriptors of GES is that: "Marine litter does not cause harm to the coastal and marine environment". The terms "plastic soup" and "plastic beaches" have been increasingly used in public media to attract attention to the ubiquitous presence of marine litter in our oceans and waterways and on our shores.

1.1. The extent of the problem

Marine litter is a problem of global dimensions, affecting all oceans on the planet to different degrees. Surveys in the North Sea have found, on average, more than 500 items of marine litter per 100-m coastline (OSPAR, 2007). In areas close to shipping routes, public beaches and river deltas, higher densities of beach litter above 1 000 items per 100 m are not uncommon (HELCOM, 2007).

The composition of marine litter is very diverse consisting of plastics (e.g. bags, bottles), wood (boxes, fragments), glass (bottles), metals (cans, aerosol containers), rubber (tires, boots), cigarette

☆ The authors are grateful to Dr Heather Leslie for valuable comments on an earlier draft. The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement No 308370. The contents of this publication are the sole responsibility of the CleanSea project and can in no way be taken to reflect the views of the European Union.

* Corresponding author. Institute for Environmental Studies, VU University Amsterdam, De Boelelaan 1087, 1081 HV Amsterdam, The Netherlands.
E-mail addresses: e.papyrakis@vu.nl, e.papyrakis@uea.ac.uk (E. Papyrakis).

http://dx.doi.org/10.1016/j.ocecoaman.2014.08.005
0964-5691/

butts, etc. (Fanshawe and Everand, 2002). Plastics are by far the most abundant type of marine debris (European Commission, 2012) and in the Baltic and North Sea, for example, they account for approximately 70% of total marine litter on shorelines (e.g. OSPAR, 2007, 2009; GEF, 2011). The primary plastic items of marine litter consist of bottles, plastic bags and packaging materials. Wood and glass correspond to another 10% of total marine litter each. Some of the most common items of marine litter identified between 1989 and 2007 (at the global level) included plastic bags (9.4%), caps/lids (9.1%), food wrappers (8.9), cups and cutlery (7.2%) and small (less than 2 L) plastic beverage bottles (5.5%) (UNEP, 2009).

In general, studies divide the sources of marine litter into land-based and sea-based ones. The majority of marine litter originates from land-based activities as a result of debris transported by the wind or nearby waterways. The original source of land-based debris can vary from illegal dumping of domestic and industrial waste, public littering, inadequately covered waste containers and poorly managed waste dumps (UNEP, 2009). Often less than 20% of all marine litter is attributed to sea-based sources, e.g. related to fishing vessels or cruise ships (Öko-Institut, 2012). There is very sparse information about the links between the amount of overall polluting material (e.g. plastic bags) and the extent to which this becomes marine litter (e.g. plastic in the sea). There are, though, a few studies that have attempted to attribute marine litter to particular sectors and economic activities. The 2007 UK Beachwater 'beach litter' 'survey (OSPAR, 2009) found that recreational and beach-related tourism activities account for almost 42% of all litter found on the beach produced, while the shipping industry contributes another 35%. Fishing accounts for another 14% and sewage related debris for another 6%.

There is a wide range of serious threats associated with marine litter that have brought increasing attention to the problem. Marine litter negatively impacts wildlife and more than 180 species (birds, fish, turtles, mammals) have been found to ingest plastic debris by mistaking it as food (Davison and Asch, 2011; Murray and Cowie, 2011) – a recent study found that almost 94% of sea birds in the North sea have ingested small plastic particles to some extent (OSPAR, 2010). Fishing gear and packaging material is also associated with entanglement of marine animals (turtles, fish, seals). Marine debris can also affect human health and safety (e.g. Ten Brink et al., 2009; Mouat et al., 2010) by degrading the quality of bathing water and contaminating seafood. The cost of cleaning marine litter can be significant – for example, we know that UK municipalities spend approximately €18 million each year removing beach litter, which is a 37% increase compared to the early 1990s (Mouat et al., 2010). Similarly, removing beach litter costs municipalities in the Netherlands and Belgium approximately €10.4 million per year (Mouat et al., 2010). Marine litter also impacts negatively on the fishing industry. In a recent study, 86% of Scottish vessels surveyed confirmed a restricted catch due to marine litter (Mouat et al., 2010) and estimated that marine litter costs the Scottish fishing fleet between €11.7 million and €13 million on average each year, which is the equivalent of 5% of the total revenue of affected fisheries).

As a result of the complexities caused by the diverse origin of marine litter, a wide range of instruments have been proposed to deal with it across multiple sectors. Some of them are regulatory policy instruments which focus on adopting relevant legislation to help minimise marine litter (such as the EU Directive 2000/59/EC on port reception facilities for ship-generated waste and cargo residues). Other instruments are economic in nature and attempt to indirectly influence the amount of marine litter through the imposition of economic (dis)incentives (such as taxes, charges, or subsidies).

The focus of this paper is on the latter type of market-based (economic) instruments[1] that aim at increasing the relative monetary costs of economic activities that result in marine litter. Section 2 contains a brief introduction on the theoretical background of such instruments and on the main types that can be distinguished. In Section 3, we provide a concise review of economic instruments that have either been proposed or applied to reduce marine litter. While many of these are listed in other reports (e.g. the guidelines published by UNEP, see Ten Brink et al., 2009), our analysis builds on them by explicitly assessing their cost of implementation, level of effectiveness as well as indirect environmental and socio-economic effects (externalities) that may arise as a result of their implementation. Section 4 presents conclusions and provides recommendations to reduce different marine litter types using economic instruments.

2. Economic instruments and marine litter: a theoretical framework

The marine litter problem is a typical example of what environmental economists call a 'public bad' – i.e. a product that negatively affects our welfare in a non-excludable and non-rival manner (which in effect makes it the opposite of a 'public good'; see Common and Stagl, 2005; Kolstad, 2010). *Non-excludability* refers to the fact it is often very difficult or expensive to exclude certain individuals alone from the loss of welfare (in terms of damage, disamenity etc.) associated with marine litter (i.e. *everyone* suffers to a certain degree irrespective of whether he or she contributes to the marine litter problem). *Non-rivalry* refers to the fact that the disutility experienced by any individual exposed to marine litter does not decrease the disutility experienced by others. As in the case of all public bads, marine litter is a typical example of a market failure attributed to the following two reasons:

- *missing markets:* there is no market to determine the desired level of marine litter – those contributing to marine litter and those demanding a reduction of it do not physically meet to negotiate solutions to the problem in the form of appropriate compensation mechanisms or other implicit pricing (see Batie and Ervin (2001) for a discussion on missing markets and environmental public bads). Even if such direct arrangements were possible, their transaction costs would render them prohibitively expensive as a result of time-consuming procedures involving large number of individuals and firms.
- *negative externalities:* these are negative side-effects of actions by producers and consumers that affect the welfare or production of others (Chipman and Tian, 2012; Cornes and Sandler, 1996). As it often happens, those responsible for these negative externalities (e.g. a firm or a consumer making use of plastic bags and other packaging that contribute to marine litter) do not necessarily incur the full costs of their actions (e.g. the marine litter attributed loss of tourism revenues or health and safety impacts). As a result of the costs of marine litter not being internalised, those responsible for them have limited incentives to change their behaviour and minimise their impacts on the marine environment. This *free-riding problem* results in the overprovision of the public bad

[1] There is no clear distinction between the terms 'market based instruments' and 'economic instruments' and they are often interchangeably used (e.g. in EEA, 2005). Possibly the term 'economic instrument' refers more to the financial incentive that the instrument conveys, whereas 'market-based' emphasises the role of the market mechanism in achieving the environmental objective. In that sense, instruments such as ecolabelling could also be called 'market based', whereas they do not provide financial incentives and therefore are not 'economic instruments'.

(i.e. excessive levels of marine litter; e.g. see Morrissey et al., 2002).

Basically, policy-makers can make use of two different types of policy instruments in order to limit marine litter (Sterner, 2003). The so-called "*command-and-control*" measures involve direct regulation of activities that contribute to marine litter by legislation (e.g. smoking prohibition on beaches or adoption of minimum standards for port reception facilities and waste storage). *Economic instruments* (the focus of this paper) are the second type of instruments that policymakers have at their disposal. Economic instruments do not prescribe the use of certain technologies or adoption of specific standards nor do they dictate that all firms or consumers reduce their marine litter by a prescribed amount. Instead, they provide (dis)incentives that allow firms and individuals greater flexibility in their approach to pollution management. Command-and-control measures may be preferred when there is an urgent need of a swift intervention. In large, though, economists argue that economic instruments are more cost-efficient as a means to reduce environmental externalities (as in the case of marine litter) – financial incentives ensure that such reductions are first met by those who can do so at the lowest cost (for a discussion, see Harrington and Morgenstern, 2007; Hepburn, 2006). Economic instruments can stimulate a gradual change in the behaviour of users by allowing environmental costs (or benefits) to be internalised into the prices of products or activities (and hence stimulate transitions to new innovative ways of production or consumption patterns that reduce litter, see Lanoie et al., 2011; Mazzanti and Zoboli, 2006).

Policy makers need to consider several criteria when deciding on the suitability of an economic instrument in tackling marine litter. *Effectiveness* is naturally a key determining factor – that is, the ability to produce a desired result, such as a drastic reduction in marine litter. The magnitude of change in behaviour as a result of price signals (commonly referred to as 'elasticity' in economics), and hence the effectiveness of the instrument in terms of reducing litter, will depend on the adopted level of the price signal and other instrument design features (such as its 'point of incidence' in the product-waste chain), as well as on various cultural, socio-demographic and economic factors. The *cost of implementation* (*cost-efficiency*) is another important factor that influences which instrument to opt for and it focuses on how to allocate scarce resources (e.g. public funds) to meet a certain environmental objective. Effectiveness and efficiency do not necessarily go hand in hand – a very effective economic instrument, for example, can come at a very high cost due to high transaction costs. Furthermore, economic instruments used to reduce marine litter may have additional socio-economic *side-effects* (positive or negative) that extend beyond the direct impacts of reducing pollution (e.g. in the form of employment gains or losses in associated economic sectors, changes in competitiveness as a result of price distortions or improvements in environmental amenity services). There is a wide range of economic instruments that can make use of either positive or negative financial incentives in order to tackle the marine litter problem:

2.1. Disincentives

Financial disincentives (such as penalties, taxes and charges) are applied to discourage behaviour that may contribute to the problem of marine litter. Usually, such disincentives do not lead to a complete change in behaviour. To the extent that the undesirable behaviour continues to exist, the disincentive (if adequately enforced) will also continue to raise government revenues. These revenues can either accrue to the general public budget, or be used for activities related to the marine litter problem, e.g. to finance specific remediation programmes (see Cruz and McLaughlin, 2008 for Cuba; Williams, 1996 for Australia). The latter way of re-spending may increase the public acceptability of the instrument.

Charges and taxes can be seen as price tags on economic activities that contribute to marine litter (that hence discourage certain behaviour by distorting relative prices). While taxes and charges are often collected on consumptive or productive activity that contributes to marine litter, *financial penalties* do not recognise a "pollute and pay" behaviour as legitimate and hence assume that littering should entail some form of monetary punishment (they are therefore complementary to 'command-and-control' instruments). A challenge faced by policymakers is to set taxes and penalties at an appropriate level that allows for certain targets of marine litter reduction to be met (for this reason economists often calculate price elasticities in order to measure anticipated changes in polluting consumption or production in response to changes in prices). *Liability* legislation can, in principle, also be used to make polluters pay for environmental damage, although its applicability in practice is limited due to the need to establish a causal link between the damage and specific activities (see e.g. OECD, 2009).

2.2. Incentives

Financial incentives (deposit-refund schemes, subsidies, direct payments, price differentiation, preferential treatments) are applied to stimulate behaviour that alleviates the marine litter problem, e.g. in the form of encouraging recycling and reuse of materials and proper waste disposal. *Subsidies and fiscal incentives* are remunerations (normally provided by the government) for any type of activities that prevent marine litter (Engel et al., 2008). *Deposit-refund schemes* reward those consumers who return packaging material and residues to manufacturers (and hence encourage recycling and reuse of materials) by offering the refund of a deposit that was charged upon the purchase of the potentially polluting product. *Price differentiation* can be used to encourage consumers to choose products and services that lead to less environmental damage (in this case marine litter). *Preferential treatment* is often a government-supported scheme (e.g. for the awards of contracts or permits) that positively discriminates in favour of firms that are more environmentally friendly.

3. Economic instruments and marine litter: evidence

We discuss the main economic instruments that have been identified in the literature as a means to reduce marine litter, as well as some of their key characteristics in terms of effectiveness, cost of implementation and indirect side-effects. Table 1 provides a summary of them.

3.1. Disincentives

3.1.1. Penalties

McIlgorm et al. (2011) discuss the use of financial penalties in discouraging the illegal disposal of marine litter in the Asia-Pacific region and how the effectiveness of such measures is likely to be conditional on the ability to identify the polluter and enforce the penalty. Insurance premiums can be linked to the risk of damage from marine litter in the fishing sector as an implicit penalty for waste-generating activity (McIlgorm et al., 2009). Ten Brink et al. (2009) note that many communities impose fines aimed at discouraging anti-social behaviour including the improper discarding of waste and trash. They suggest that revenues can be used to fund awareness campaigns or provide additional waste receptacles and other infrastructure.

Table 1
Studies on economic instruments and activities associated with marine litter.

Type of economic instrument	Type of (potential) litter	Study	Geographical focus	Effectiveness	Cost of implementation	Indirect effects
Penalties	General	Williams (1996)	Australia	Limited (by weak political support)	–	–
Penalties	General	McIlgorm et al. (2011)	Asia–Pacific Region	Conditional	High	–
Penalties	General	Williams (1996)	Australia	Limited (by weak political support)	–	–
Taxes (tourist taxes)	General	Burns (2010)	England	Limited by opposition within the tourism sector	–	Possible loss of competitiveness and visitors
Taxes	Plastic Bags	Convery et al. (2007)	Ireland	High	Low	Minor (loss of competitiveness, lower purchasing capacity)
Taxes	General	Cruz and McLaughlin (2008)	US/Mexico/Cuba/EU	Limited in Cuba (inadequate infrastructure/skills)	–	–
Taxes	General	Diop et al. (2011)	Africa	–	–	–
Taxes (tourist taxes)	General	do Valle et al. (2012)	Portugal	Low	–	–
Taxes (tourist taxes)	General	Dodds et al. (2010)	Thailand/ Indonesia	High for areas where tourism is prominent economic activity	–	Loss of competitiveness and tourist arrivals
Taxes	Plastic Bags	He (2012)	China	High, but constrained by extensive informal economy	Low	Price of bags set by individual shops which influences competition
Taxes	General	McIlgorm et al. (2011)	Asia–Pacific Region	Conditional	High	–
Taxes	Plastic bags	Nahman (2010)	South Africa	Effective in reducing demand for plastic bags, not effective in recycling old plastic bags	–	Possible loss of employment in the plastic bags industry
Taxes	General	Ochiewo et al. (2007)	West Indian Ocean region	Limited (corruption – Madagascar, low pricing of plastics – Mauritius, reluctance of residents to pay fees – Tanzania)	High	–
Deposit-refund scheme	Bottles	Ferrara and Plourde (2003)	General	Limited by consumer preferences	High	Potential increased demand for non-refillable containers
Deposit-refund scheme	Beverage containers (cans/bottles)	Lavee (2010)	Israel	–	Low	Cleaner public spaces, energy-saving, job creation
Deposit-refund scheme	General	McIlgorm et al. (2011)	Asia–Pacific Region	Conditional	High	–
Deposit-refund scheme	Plastic bottles	Numata and Namagi (2012)	Japan	Limited (by consumer demand)	–	–
Deposit-refund scheme	General	Ochiewo et al. (2007)	West Indian Ocean region	Limited (corruption – Madagascar, low pricing of plastics – Mauritius)	High	–
Deposit-refund scheme	General	Walls (2011)	US/Canada/Germany	In theory more effective than environmental taxes	–	–
Subsidies	General	Diop et al. (2011)	Africa	–	–	–
Subsidies	General	McIlgorm et al. (2011)	Asia–Pacific Region	Conditional	High	–
Subsidies	General	Williams (1996)	Australia	Limited (by weak political support)	–	–
Direct payments/ awards (incentives for fishermen to collect litter)	Fishing gear, bottles, plastics	Cho (2009)	South Korea	Not mentioned but likely to be high as suggested by increasing rates of participation	Relatively low (compared to direct cost of litter removal)	Additional income for fishermen
Direct payments/ awards	General	McIlgorm et al. (2011)	Asia–Pacific Region	Conditional	High	–
Direct payments/ awards	Plastic bags	Nahman (2010)	South Africa	Low	–	–
Direct payments/ awards	General	Ochiewo et al. (2007)	West Indian Ocean region	Limited (corruption – Madagascar)	High	–
Direct payments/ awards	General	Williams (1996)	Australia	Limited (by weak political support)	–	–
Price differentiation	Plastic Bags	Anstine (2000)	US (New Jersey)	Low	–	–

Table 1 (*continued*)

Type of economic instrument	Type of (potential) litter	Study	Geographical focus	Effectiveness	Cost of implementation	Indirect effects
Best-practice certification (preferential treatment)	General	Diop et al. (2011)	Africa	–	–	–

3.1.2. Taxes/charges on products

Several papers advocate the use of taxes or charges on plastic items as a means to discourage their consumption and reduce plastic marine litter (Diop et al., 2011; McIlgorm et al., 2011). Such taxes and charges can be levied at different points in the value chain (production of feedstocks or final products; wholesale; distribution) and their revenues can be used to reduce the negative externalities associated with the production and consumption of products (Ecorys, 2011).

One of the most successful levies on plastic bags has been applied in Ireland, where a tax of €0.15 per bag was introduced in 2002 resulting in a gradual reduction in plastic bag use by 90% (Convery et al., 2007). Within its first year of implementation the number of 'clear areas' (with no evidence of plastic litter) increased by 21%. Furthermore, while plastic bag litter accounted for 5% of the national litter composition before the adoption of the levy, this fell to only 0.22% by 2004. The cost of implementation is low because it is easy to integrate reporting and collection of the plastic bag tax into the current VAT system. There are some indirect effects as part of the plastic bag levy (e.g. an increase in the overall tax burden given that plastic bag tax revenues are not necessarily 'recycled' and loss of competitiveness in comparison to Northern Irish retailers), but given that plastic bag taxes are a small share of the overall shopping bill, these effects are rather minor.

In Denmark, where a tax on plastic bags (and other plastic items) was already introduced in 1994, the results were less spectacular. Initially, the use of plastic bags decreased by 60%, but afterwards it started gradually increasing again (though it did not reach the original level). In the Danish case, no data on the impact of the tax on litter are available (Ecorys, 2011). Other European countries where taxes and charges on plastic products have been implemented include Belgium, Bulgaria and Wales, and these schemes are generally considered as successful (RPA, 2013). In China, regulation to charge for plastic shopping bags since 2008 has almost halved plastic bag use – the success of the scheme has been supported by simultaneous information campaigns (and constrained by the extensive informal economy; see He, 2012). Chinese retailers can decide directly the price of plastic bags (although at no level below the acquisition cost), which can indirectly influence competition.

Hogg et al. (2011) and Ecorys (2011) point to the need to adjust charge rates to keep up with inflation; otherwise their incentive function will be gradually eroded. Experiences in South Africa confirm that fixing plastic bag levies at a low level leads to limited effectiveness that is further reduced over time (Dikgang et al., 2010; Nahman, 2010). The choice of an appropriate level of tax is instrumental in instigating desired behavioural changes – for example, a reduction in the South African bag levy from 46c to 32c per bag in 2003 swept away 20% of the original effect of the levy (in terms of reduced plastic bag sales; see Nahman, 2010).

Ten Brink et al. (2009) suggest that product charges could also be applied to the sale, distribution or use of other products such as fishing line, fishing floats and foamed plastic food containers in order to reduce the incentive to litter and to raise funds that can be made available for clean-up activities or to improve coastal waste management infrastructures. Schneider et al. (2011) suggest a product charge on cigarettes sold to address the problem of cigarette litter. They argue that the costs of mitigating the negative externalities of tobacco litter in a city the size of San Francisco (where a tobacco litter abatement fee was recently proposed) can be offset by implementing a fee of approximately $0.20 per pack.

3.1.3. Other taxes/charges

A "pay-as-you-throw" (PAYT) system for municipal waste collection can be implemented for households and small firms.[2] PAYT schemes can be quite effective in stimulating waste reduction and recycling (OECD, 2006; Oosterhuis et al., 2009; Hogg et al., 2011), but their effectiveness can be limited by incentivising illegal dumping (McIlgorm et al., 2011).

Tourist taxes do not directly contribute to the reduction of marine litter by influencing the demand for waste-generating products (as in the case of plastic bag levies) or by encouraging recycling (as in the case of PAYT). However, they can provide funds for coastal cleaning and waste collection and treatment and thus 'make the polluter pay'. Tourist taxes are, though, often treated as a means to ease budget constraints for local authorities rather than necessarily reduce marine litter or improve environmental management more broadly. In many cases they face strong opposition within the tourism industry (Burns, 2010) given that a high tourist tax may result in loss of competitiveness and reduced tourist arrivals (Dodds et al., 2010). A quantitative survey in Thailand on the willingness of tourists to pay such taxes revealed that this can be high for older and wealthier respondents, as well as when respondents identify a direct link between the tax and litter control (Dodds et al., 2010). In some cases more than 40% of respondents are willing to pay more than 10 US dollars per visit. In tourist areas attracting less wealthy tourists (see the study by do Valle et al., 2012 on Algarve), the estimated willingness to pay for a tourist tax earmarked for environmental protection can be very limited and confined to small segments of the tourist population that display a very strong affinity with the environment. Using a General Equilibrium model, Schubert (2009) stresses that whether one should opt for a positive tourist tax or a negative one (in effect a subsidy) depends on the type of externalities that might arise from tourism (e.g. some tourist activities may provide incentives for designating local natural reserves and establishing waste control systems).

Similar to tourist taxes, other kinds of taxes and charges can also be applied to make those who (are likely to) contribute to the marine litter problem pay their fair share. For example, Ten Brink et al. (2009) suggest that portions of port reception, ship berthing, and commercial and recreational fishing fees can be designated to improve waste management infrastructure and start innovative programmes that remove marine litter from the ocean. In addition to tourist taxes, car park fees (e.g., near waterfronts) and waterfront

[2] Medium and large firms usually already pay a charge in proportion to the amount of waste produced and offered for treatment by public or private enterprises.

business charges could be earmarked for beach cleaning, waste infrastructure and awareness-raising programmes. The effectiveness of taxes in reducing marine litter, particularly in developing countries, can be limited as a result of lack of skilled personnel, infrastructure and sophisticated monitoring systems (see Cruz and McLaughlin, 2008 for a study on Cuba).

3.1.4. Liability

Making polluters liable for the damage they cause is the most straightforward application of the 'polluter pays principle'. However, in practice its applicability is constrained by the need to establish a firm and undisputable link between the polluting behaviour and the damage caused. Ten Brink et al. (2009) suggest that in the area of marine litter, liability could be linked to the cost of the clean-up and to a compensation scheme for those whose livelihood is compromised by the impacts of marine litter. However, they acknowledge that this is a non-trivial scheme to set up and requires an adequate legal framework and capacity. They add that the application of liabilities is practically impossible for certain international sources of marine pollution, as well as operationally difficult, particularly in developing countries.

3.2. Incentives

3.2.1. Deposit-refund schemes

Deposit-refund schemes (DRS) involve the payment of a deposit upon the purchase of a polluting product (e.g. bottles/cans) that can be refunded once the product or its residues are returned to the seller or established collection point. Such schemes can incentivise proper handling of waste and recycling (McIlgorm et al., 2011; Ochiewo et al., 2007). They can be applied voluntarily by industry, but can also be mandatory (as for instance in Denmark, Germany and a number of states in the USA). In the latter case, they function as an instrument of public policy.

International experience shows that DRS can achieve very high return rates (Oosterhuis et al., 2009; Ten Brink et al., 2009; Ecorys, 2011) and that they do lead to a reduction in litter (Hogg et al., 2011; Ecorys, 2011; EPA, 2001). The cost of implementation can, though, be high, especially when distances to bottling consolidation facilities are large and the scheme targets a wide array of packaging types (Ferrara and Plourde, 2003). This is particularly the case for handling returned but not reusable containers. Nonetheless, DRS can be more cost effective in some cases when compared to traditional waste management (e.g. see the cost-benefit study by Lavee (2010) for the Israeli DRS). A DRS that involves reusable plastic bottles can minimise costs (by reducing the costs of recycling and processing), but may face considerable resistance from consumers who are often concerned about container flaws and stains (see Numata and Managi (2012) for evidence on a 2009 pilot project in Yokohama and Chiba in Japan). The size of the deposit also needs to be adjusted in line with inflation in order to act as an effective incentive (in the US, with the exception of California, the deposit has stayed approximately constant over the last 40 years, see Walls, 2011). According to Hill et al. (2008) the cost of a DRS tends to be higher than its benefits (which consist of the retention of unclaimed deposits plus the value of the reclaimed material). This is confirmed by Ecorys (2011), who cite a study finding a net annual cost of € 286 million for the German drinks containers DRS.

The effectiveness of DRS schemes can be further limited by strong consumer preferences for throw-away convenience packages. If the scheme results in increases in the cost of drinks supplied in refillable containers, this might skew demand towards drinks supplied in non-refillable containers. Finally, DRS can raise concerns if they create *de facto* trade barriers (Hogg et al., 2011).

3.2.2. Subsidies and fiscal incentives

McIlgorm et al. (2011) suggest that the general tax system can be used to finance the subsidised use of recyclable materials and Williams (1996) proposes the use of subsidies and soft loans more broadly for the adoption of waste minimisation technologies (see also Diop et al., 2011; Ochiewo et al., 2007). Ochiewo et al. (2007) propose the use of tax breaks for recycling companies as a means to reduce marine litter in Mauritius (although the current low pricing of virgin plastics produces an effect in the opposite direction). Financial and technical support could be given for the installation of waste management systems on board fishing vessels, leisure crafts and larger ships which have inadequate facilities (Ten Brink et al., 2009).

3.2.3. Direct payments/awards

Ten Brink et al. (2009) mention the option of using award-based incentives for coastal villages with Integrated Waste Management (IWM) systems. These programmes incorporate all the policies and technologies that are necessary to manage the entire waste stream. In some cases (e.g. in South Africa, see Ochiewo et al., 2007) the industry and the government together provide joint grants to non-governmental and community organisations that promote recycling, educational programmes and help establish businesses that produce items out of waste material.

In some countries (e.g. Indonesia, South Africa) private companies offer payments for empty plastic bottles and bags for recycling that are collected by the urban poor (McIlgorm et al., 2011; Nahman, 2010). In South Africa recycling buy-back centres have been established for such purposes although they are underfunded and rely on funds collected from the imposed plastic bag levy (Nahman, 2010).

Waste reception schemes at port with dumping incentive payments can incentivise boats/vessels to discharge all waste prior to departure (McIlgorm et al., 2011) and/or alternatively provide rewards for fishing vessels that return waste to shore (Ochiewo et al., 2007). Incentives to fishermen for reporting on and the removal of litter are suggested by Ten Brink et al. (2009).[3] In South Korea an incentive programme was set up in 2002 to pay fishermen for the collection of marine litter and they removed approximately 1800 tons of marine litter between 2002 and 2007 (there is a compensation of US$4 per 40 L bag, see Cho, 2009).

Sophisticated financial instruments based on payments can also apply for the case of marine waste generating firms, where performance bonds (where money is held in trust) can be fully repaid only once compliance with some predetermined standards is met (Williams, 1996).

3.2.4. Price differentiation

A study by Anstine (2000) examined the possibility of using price differentiation as a mechanism to encourage recycling of plastic. Through a hedonic price approach he examined the willingness of consumers to pay a higher price for plastic bags made with recycled material, which could then partly finance the collection of plastic litter and reuse in recycling. There was no empirical support, though, pointing to consumers being willing to pay a higher price for kitchen bags made with recycled plastic.

3.2.5. Preferential treatment and public procurement

When governments/authorities are themselves involved in market transactions, they can decide to include environmental

[3] A voluntary 'Fishing for Litter' programme (without financial incentives) is already operational, as an initiative of municipalities around the North Sea (see www.kimointernational.org, accessed 18 December 2013).

considerations in their decisions, when awarding a contract or a permit. Such 'green procurement' approaches could also be applied in marine litter related issues, e.g. by making the use of recyclable or degradable materials an award criterion when concessions for commercial activities are issued in a competitive bidding procedure (see also Ten Brink et al., 2009).

4. Conclusion

Marine litter has been increasingly recognised as a major threat to marine ecosystems negatively affecting local species and habitats, and human health. They also pose an economic challenge to communities that must clean up litter along beaches. Fortunately, there is a great potential to reduce the amount of marine litter through a combination of market-based instruments (environmental taxes, direct payments, deposit-refund schemes etc). In this paper we carried out a literature review on economic instruments that have either been used or proposed for the purpose of reducing marine litter (summarised in Table 1). Based on our analysis we can draw some conclusions on the appropriate use of economic instruments as a means to reduce different types of marine litter:

- In the case of *plastic bags*, there is a lot of evidence (both from developed and developing economies) suggesting that *taxes and charges* can be very successful in reducing their use at a relatively low cost. Such product charges could also be extended to the case of *fishing equipment* and *plastic foam food containers.*
- In the case of *municipal waste collection*, a '*pay-as-you-throw*' *charge* can be applied for local households and firms to incentivise waste reduction. In coastal areas, waste collection and treatment can be further supported by the collection of *tourist taxes*, although there is a high risk these might be used for other purposes.
- In the case of *bottles and cans*, *deposit-and-refund schemes* have achieved high return rates in several countries, although the cost of implementation can be large when multiple types of packaging are targeted. Schemes that aim at recycling rather than reusing collected material are likely to attract more consumer support. In developing countries, payments for empty *bottles* or other *plastic material* have stimulated recycling and provided income for some of the urban poor.
- In the *fishing industry*, *rewards* for fishing vessels that return waste to shore have been shown to both reduce marine litter as well as complement fishermen's income.

Unfortunately, we still know little about the links between the amount of overall polluting material (e.g. plastic bags) and the extent to which this becomes marine litter (e.g. plastic in the sea) – further research should attempt to quantify these links in order to prioritise interventions. Nevertheless, we know that the vast majority of marine litter comes from land-based sources and consists of plastic (primarily in the form of beverage bottles, food wrappers and bags). Economic instruments that target land-based litter more broadly will, hence, also contribute to marine litter reduction – the corresponding decline in marine litter will naturally depend both on the effectiveness of the chosen economic instrument, as well as the exact causal pathways that link marine litter with their original land-based sources. Furthermore, there is no "one size fits all" economic instrument and the choice of an appropriate intervention is case specific, largely depending on the tackled source of pollution, the country's institutional characteristics and infrastructure, consumer preferences and habitual behaviour and the economy's overall sectoral composition. We summarise below some of these important *conditionalities* upon which the effective use of economic instruments may depend:

- Public revenues raised through environmental taxation, penalties and charges are often treated by implementing authorities as an additional source of income without necessarily funding marine litter reducing activities (although they can reduce the demand of marine-polluting products by altering their relative prices). While this can be justified from an economic point of view (the financial disincentive is the core of the instrument; the revenue is a side effect), earmarking the revenues (at least partly) for marine litter reduction purposes will further support the objective to reduce marine litter as well as potentially enhance the public acceptance of the instrument.
- Economic instruments (e.g. environmental taxes) may locally reduce marine-polluting material but at the same time spatially relocate the marine-polluting consumption/production elsewhere. Substitution effects can also take place across products (e.g. a deposit-refund scheme targeting refillable containers may shift consumption to non-refillable ones, with little effect on the overall amount of marine-polluting material produced).
- Economic instruments often change consumer behaviour but do not necessarily affect habitual actions permanently. The effect of an economic instrument may be temporary and last only as long as the instrument is in place.
- Economic instruments need to be designed with the socio-economic characteristics of the population in mind. The elasticity of consumption (of potentially marine-polluting products) is income specific, and even for similar income groups, response to economic (dis)incentives may depend on the culture, substitution effects across products and consumer preferences.

References

Anstine, J., 2000. Consumers' willingness to pay for recycled content in plastic kitchen garbage bags: a hedonic price approach. Appl. Econ. Let. 7, 35–39.
Batie, S.S., Ervin, D.E., 2001. Transgenic crops and the environment: missing markets and public roles. Environ. Dev. Econ. 6, 435–457.
Burns, S., 2010. Local authorities, funding tourism services and tourist taxes. Loc. Econ. 25, 47–57.
Chipman, J.S., Tian, G., 2012. Detrimental externalities, pollution rights and the "Coase theorem". Econ. Theor. 49, 309–327.
Cho, D.-O., 2009. The incentive program for fishermen to collect marine debris in Korea. Mar. Pollut. Bul. 58, 415–417.
Common, M., Stagl, S., 2005. Ecological Economics, second ed. Cambridge University Press, Cambridge, UK.
Convery, F., McDonnell, S., Ferreira, S., 2007. The most popular tax in Europe? Lessons from the Irish plastic bags levy. Environ. Res. Econ. 38, 1–11.
Cornes, R., Sandler, T., 1996. The Theory of Externalities, Public Goods and Club Goods, first ed. Cambridge University Press, Cambridge, UK.
Cruz, I., McLaughlin, R., 2008. Contrasting marine policies in the United States, Mexico, Cuba and the European Union: searching for an integrated strategy for the Gulf of Mexico region. Oc. Coast. Manag. 51, 826–838.
Davison, P., Asch, R.G., 2011. Plastic ingestion by mesopelagic fishes in the North Pacific Subtropical Gyre. Mar. Ecol. Progr. Ser. 432, 173–180.
Dikgang, J., Leiman, A., Visser, M., 2010. Analysis of the Plastic Bag Levy in South Africa. Policy Paper Number 18. Environmental Policy Research Unit, School of Economics, University of Cape Town.
Diop, S., Arthurton, R., Scheren, P., Kitheka, J., Koranteng, K., Payet, R., 2011. The coastal and marine environment of Western and Eastern Africa: challenges to sustainable management and socioeconomic development. In: Wolanski, E., McLusky, D.S. (Eds.), Treatise on Estuarine and Coastal Science. Waltham Academic Press, London, UK, pp. 315–335.
do Valle, P.O., Pintassilgo, P., Matias, A., Andre, F., 2012. Tourist attitudes towards an accommodation tax earmarked for environmental protection: a survey in the Algarve. Tour. Manag. 33, 1408–1416.
Dodds, R., Graci, S.R., Holmes, M., 2010. Does the tourist care? A comparison of tourists in Koh Phi Phi, Thailand and Gili Trawangan, Indonesia. J. Sust. Tour. 18, 207–222.
Ecorys, October 2011. The Role of Market-based Instruments in Achieving a Resource Efficient Economy. Report for the European Commission, DG Environment. Ecorys, Cambridge Econometrics and COWI, Rotterdam.
Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice: an overview of the issues. Ecol. Econ. 65, 663–674.
European Commission, 2012. Overview of EU Policies, Legislation and Initiatives Related to Marine Litter. Commission Staff Working Document, SWD(2012 365 final), Brussels.

EEA, 2005. Market-based Instruments for Environmental Policy in Europe. Technical Report 8/2005. European Environment Agency, Copenhagen.
EPA, 2001. The United States Experience with Economic Incentives for Protecting the Environment. Office of Policy, Economics, and Innovation Office of the Administrator U.S. Environmental Protection Agency, Washington, DC.
Fanshawe, T., Everand, M., 2002. The Impacts of Marine Litter. Marine Pollution Monitoring Group (Report of the Marine Litter Task Team).
Ferrara, I., Plourde, C., 2003. Refillable versus non-refillable containers: the impact of regulatory measures on packaging mix and quality choices. Res. Pol. 29, 1–13.
GEF, 2011. Marine debris as a Global Environmental Problem: Introducing a Solutions Based Framework Focused on Plastic. Report. Global Environment Facility, Washington, DC.
Harrington, W., Morgenstern, R.D., 2007. "Economic incentives versus command and control: what's the best approach for solving environmental problems? In: Visgilio, G.R., Whitelaw, D.M. (Eds.), Acid in the Environment: Lessons Learned and Future Prospects. Springer, New York, pp. 233–240.
He, H., 2012. Effects of environmental policy on consumption: lessons from the Chinese plastic bag regulation. Environ. Develop. Econ. 17, 407–431.
HELCOM, 2007. Marine Litter in the Baltic Sea Region: Assessment and Priorities for Response (Report. Helsinki, Finland).
Hepburn, C.J., 2006. Regulating by prices, quantities or both: an update and an overview. Oxf. Rev. Econ. Pol. 22, 226–247.
Hill, J., Hislop, H., Bégin, A.-E., 2008. Good Product, Bad Product? Making the Case for Product Levies. Green Alliance, London, UK.
Hogg, D., Sherrington, C., Vergunst, T., 2011. A Comparative Study on Economic Instruments Promoting Waste Prevention (Final Report to Bruxelles Environnement. Bristol, UK).
Kolstad, C.D., 2010. Environmental Economics, third ed. Oxford University Press, Oxford, UK.
Lanoie, P., Laurent-Lucchetti, J., Johnstone, N., Ambec, S., 2011. Environmental policy, innovation and performance: new insights on the Porter hypothesis. J. Econ. Manag. Strat. 20, 803–842.
Lavee, D., 2010. A cost-benefit analysis of a deposit-refund program for beverage containers in Israel. Waste Manag. 30, 338–345.
Mazzanti, M., Zoboli, R., 2006. Economic instruments and induced innovation: the European policies on end-of-life vehicles. Ecol. Econ. 58, 318–337.
Mcllgorm, A., Campbell, H.F., Rule, M.J., 2009. Understanding the Economic Benefits and Costs of Controlling Marine Debris in the APEC Region (Report commissioned for the APEC Secretariat and the United Nations Environment Programme).
Mcllgorm, A., Campbell, H.F., Rule, M.J., 2011. The economic cost and control of marine debris damage in the Asia-Pacific region. Oc. Coast. Manag. 54, 643–651.
Morrissey, O., te Velde, D., Hewitt, A., 2002. Defining International Public Goods: Conceptual Issues. In: Ferroni, M., Mody, A. (Eds.), International Public Goods: Incentives, Measurement, and Financing. Kluwer Academic Publishers, Dordrecht, pp. 31–46.
Mouat, J., Lozano, R.L., Bateson, H., 2010. Economic Impacts of Marine Litter. Report. KIMO, Lerwick, UK.
Murray, F., Cowie, P., 2011. Plastic contamination in the decapod crustacean Nephrops norvegicus. Mar. Pollut. Bul. 62, 1207–1217.
Nahman, A., 2010. Extended producer responsibility for packaging waste in South Africa: current approaches and lessons learned. Resour. Conserv. Rec. 54, 155–162.
Numata, D., Managi, S., 2012. Demand for refilled reusable products. Environ. Econ. Polic. Stud. 14, 421–436.
Ochiewo, J., Rasolofojaona, H., Seewoobaduth, J., Pereira, M., Gonzalves, C., Ryan, P., Lukambusi, L., 2007. Regional Overview and Assessment of Marine Litter Related Activities in the West Indian Ocean Region (WIOMSA Report to the United Nations Environment Programme).
OECD, 2006. Impacts of Unit-based Waste Collection Charges. ENV/EPOC/WGWPR(200510/FINAL), 15 May 2006. Organisation for Economic Co-operation and Development, Paris.
OECD, 2009. Environmental liability for damage to natural resources in OECD countries: the concept and key approaches. Discussion paper, ENV/EPOC/EAP/REPIN(2009)1. In: Task Force for the Implementation of the Environmental Action Programme for Central and Eastern Europe, Caucasus and Central Asia.10-12 June 2009, Chisinau, Moldova.
Öko-Institut, 2012. Study on Land-sourced Litter (LSL) in the Marine Environment: Review of Sources and Literature. Report. Öko-Institut, Freiburg, Germany.
Oosterhuis, F.H., Bartelings, H., Linderhof, V.G.M., van Beukering, P.J.H., 2009. Economic Instruments and Waste Policies in the Netherlands. Inventory and Options for Extended Use. IVM report (R-09/01). Institute for Environmental Studies, VU University, Amsterdam, the Netherlands.
OSPAR, 2007. OSPAR Pilot Project on Monitoring Marine Beach Litter: Monitoring of Marine Litter on Beaches in the OSPAR Region. Report. OSPAR Commission, London, UK.
OSPAR, 2009. Marine litter in the North-East Atlantic Region: Assessment and Priorities for Response. Report. OSPAR Commission, London, UK.
RPA, 2013. Feasibility Study of Introducing Instruments to Prevent Littering. Final Report for DG Environment. Risk & Policy Analysts Limited, Arcadis and ABPmer, London, UK.
Schneider, J.E., Peterson, N.A., Kiss, N., Ebeid, O., Doyle, A.S., 2011. Tobacco litter costs and public policy: a framework and methodology for considering the use of fees to offset abatement costs. Tobac. Contr 20, 36–41.
Schubert, S.F., 2009. Coping with Externalities in Tourism: a Dynamic Optimal Taxation Approach. MPRA Paper No 16736. University of Munich.
Sterner, T., 2003. Policy Instruments for Environmental and Natural Resource Management. Report. Resources for the future, Washington DC.
Ten Brink, P., Lutchman, I., Bassi, S., Speck, S., Sheavly, S., Register, K., Woolaway, C., 2009. Guidelines on the Use of Market-based Instruments to Address the Problem of Marine Litter. Institute for European Environmental policy (IEEP), Brussels, Belgium.
Thompson, R.C., Moore, C.J., vom Saal, F.S., Swan, S., 2009. Plastics, the environment and human health. Phil. Trans. R. Soc. 364, 2153–2166.
UNEP, 2009. Marine litter: a Global Challenge. Report. UNEP, Nairobi, Kenya.
Walls, M., 2011. Deposit-refund Systems in Practice and Theory. Discussion Paper 11–47. Resources for the Future, Washington DC.
Williams, C., 1996. Combating marine pollution from land-based activities: Australian initiatives. Oc. Coast. Manag. 33, 87–112.